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SPECIAL STUDY OF OZONE TRANSPORT FOR THE NEW YORK METRO/HARTFORD REGIONAL STUDY

Draft Report

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CONTENTS

Figures iii
Tables iii
Introduction iv

1. Analysis of Ozone Transport 1
   - Modeling Approach 1
   - The OZIPP Model 3
   - Model Input 4

2. Summary of Findings and Results 6
   - New York Metro-Hartford Trajectory: Baseline Results . . 6
   - Intra-Connecticut Trajectory: Baseline Results 9
   - The Connecticut Ozone Problem 9
   - Impacts of SIP Control Strategies 11

Appendices

A. Air Column Trajectory Analysis and Coincident Ozone Measurements 13

B. Normalized Spatial Emission Factor - Base Year Trajectories 17

C. Initial Conditions and Daytime Emission Factors for the Control Strategy Analysis 20

FIGURES

Number		Page
I-1	Trajectory of air parcels for a) New York Metro-Hartford transport and b) Intra-Connecticut transport.	2
II-1	Hartford measured ozone levels, ppb, 6/10/74.	7

TABLES

I-1	Oxidant Precursor Data for Elizabeth, N.J., Used as Input for the New York Metro-Hartford Trajectories.	4
II-1	The New York Metro-Hartford Trajectory 1-Hour Average Ozone Maximum Value and the Percent Contribution of its Components.	8
II-2	The Intra-Connecticut Trajectory 1-Hour Average Ozone Maximum Value and the Percent Contribution of its Components.	10
II-3	Impact of Control Strategies on 1-Hour Average Maximum Ozone Value Assuming a Typical Mixing Depth of 1300 Meters.	12

INTRODUCTION

The New York Metro/Hartford regional study analyzes various approaches to improving air quality in the study region. In Phase I the study looks at pollution control measures contained in the 1979 revisions of State Implementation Plans (SIPs) for Connecticut, New Jersey, and New York. In Phase II the study examines alternative control measures which the states could have, but did not adopt under the Federal Clean Air Act of 1970 and its 1977 amendments, as well as control measures which would be required if different growth projections and energy policies are assumed for the region. Phase III takes a broader view that the first two phases, looking at control strategies which would require fundamental changes in the Federal Clean Air Act.

This volume presents the results of a special study of the ozone transport problem in the region. Section 1 reviews the relevant meteorology and air quality data, selects the air parcel trajectories to be analyzed, and describes the recommended modeling approach and its data requirements. Section 2 then summarizes the principal findings of the trajectory analysis and assesses the impacts of implementing the 1979 SIP revisions on maximum ozone values in the region. Technical appendices supply further detail on the modeling approach and input data used.

GCA would like to acknowledge the assistance of Dr. Harvey Jeffries of the Department of Environmental Science and Engineering at the University of North Carolina in reviewing the air quality modeling approach used in the trajectory analysis and providing helpful methodological guidance.

SECTION I

ANALYSIS OF OZONE TRANSPORT

Exceedance of the one-hour average National Ambient Air Quality Standard (NAAQS) for ozone (O_3) of 0.120 ppm occurs frequently throughout the region. As reported in the 1979 SIP revisions for Connecticut, during high ozone episodes readings above the standard were measured from New Jersey to Connecticut. Some of the highest ozone values occurred in Connecticut, even though the local emission rate of ozone precursors - oxides of nitrogen (NO_x) and non-methane hydrocarbons (NMHC) - are as much as an order of magnitude less than emissions in the New York metropolitan area.[1] This pattern strongly suggests that transport of ozone and its precursors from the New York City area plays an important role in determining the magnitude of ozone concentrations in Connecticut.

MODELING APPROACH

The purpose of this special study is to analyze the impact of the transport of ozone and its precursors within the New York Metro/Hartford region. The 1979 Connecticut SIP suggests that two transport conditions - between the New York City metropolitan area and Connecticut, and within Connecticut itself - can lead to exceedance of the ozone standard in the state. Trajectory analyses of air parcels and one-hour maximum ozone measurements during high ozone episodes supplied in the 1979 Connecticut SIP Revisions are reproduced in Appendix A of this volume. The transport conditions as presented in the Connecticut data had the following characteristics:

- Intra-Connecticut transport resulted in an early afternoon ozone maximum which, on worst days, caused ozone concentrations on the order of the 0.120 ppm standard throughout the state.

- New York Metro transport resulted in a second late afternoon or early evening maximum. Ozone values on the order of 0.300 ppm were measured as occuring at progressively later times across the state, moving from the southwest corner towards the northeast.

Based on the findings of the 1979 Connecticut SIP, the two trajectories shown in Figure I-1 were chosen for study. One trajectory originates in Hudson County, New Jersey at 8:00 EDT and, travelling at a characteristic windspeed of 10 mph, reaches Hartford, Connecticut at 18:00 EDT. The second trajectory, representing intra-Connecticut transport, originates in southwestern Connecticut at 8:00 EDT and, following the same path as the New York Metro air column, arrives at Hartford at 15:00 EDT.

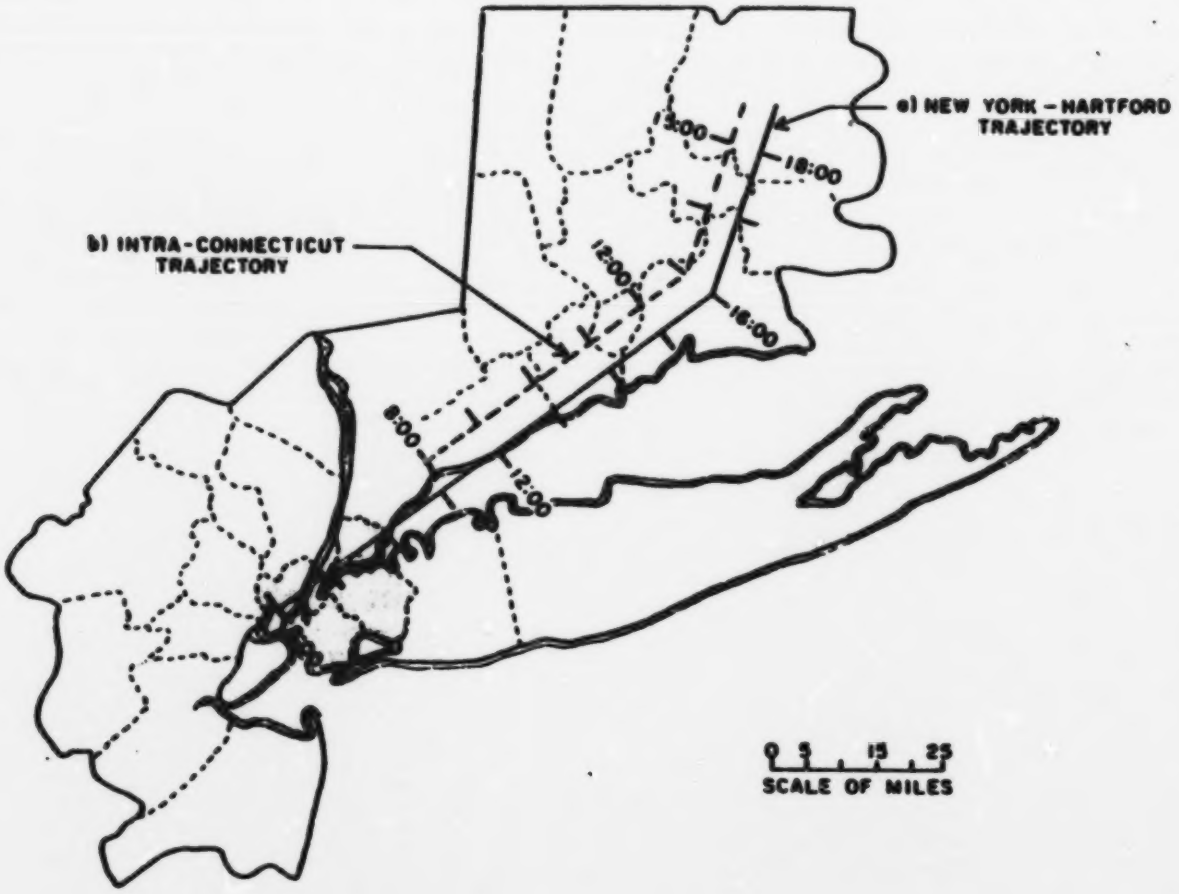

Figure I-1. Trajectory of air parcels for a) New York Metro-Hartford transport and b) Intra-Connecticut transport.

This special study will model these trajectories using the best available air quality and emissions data, in order to assess:

- Whether the ozone maximum generated by a New York-based trajectory is large enough to account for the late afternoon ozone peak measured in Connecticut.

- Whether the locally generated emissions in Connecticut are sufficient to cause exceedance of the ozone standard in the early afternoon, the normal time of the ozone maximum without transport influences.

- What are the relative importance of the various components contributing to the ozone maximum, i.e., night time emissions and background concentrations, daytime emissions, and ozone aloft.

- How effective are the stationary and mobile source control strategies proposed in the 1979 SIP revisions for reducing the predicted maximum ozone values for the two trajectories.

THE OZIPP MODEL

The photochemical and physical reactions leading to the formation of ozone within the air column along its trajectory were simulated using the Ozone Isopleth Plotting Package[3] (OZIPP). The model assumes that as a column of air moves along its path it picks up fresh emissions that become uniformly mixed within the column. The precursors react to form ozone during the course of the transport, many of the reactions being dependent upon solar radiation intensity. The NMHC is assumed to consist of a mix of hydrocarbon species with variable reactivity. The top of the mixing layer rises during transport, resulting in a dilution of the column with pollutant from aloft.

The following additional assumptions are embodied in the formulation of OZIPP:

- The lateral diffusion process is of secondary importance and the air column is horizontally and vertically well mixed.

- Horizontal boundary conditions can be ignored and the only air column-background atmosphere interaction accounted for is dilution due to the increasing mixing depth.

- Nighttime emissions are inherently included in the initial concentrations.

- Daytime hourly emissions are expressed as fractions of the nighttime emissions and, indirectly, as fractions of the initial conditions. The result of this relationship being, if initial concentrations increase, the daytime emissions increase proportionally in order to keep their fractional relationship constant.

OZIPP is designed to construct an ozone isopleth diagram relating maximum afternoon ozone concentrations to morning concentrations of NO_x and NMHC. However, the user is provided with the option of examining the ozone impact of specific morning initial conditions. GCA utilized this option to carry out a detailed analysis of the New York Metro-Hartford and intra-Connecticut trajectories.

MODEL INPUT

The OZIPP trajectory simulations require the following data inputs:

- initial concentrations of NO_x and NMHC,
- NMHC reactivity. The default hydrocarbon mix, 25 percent propylene (ppm C), 75 percent n-butane (ppm C), which is comparable to automobile exhausts, was used for all simulations,
- photolytic rate constants that vary in accordance with diurnal variations in sunlight intensity during 8 a.m. - 6 p.m. LDT for the New York Metro/Hartford region (41°N, 73°W),
- an atmospheric dilution rate,
- ozone aloft, a value of 0.085 ppm based on upwind measurements at Chester, N.J.[4] was used for all simulations,
- hourly daytime emission rates appropriate for trajectory paths, normalized with respect to the overnight emission rate at the air parcel's origin.

The initial concentrations for the New York Metro-Hartford simulations were based on 3 years of data at Elizabeth, N.J.[5] In order to test the sensitivity of the ozone maximum for a representative range of initial conditions, the trajectory was simulated using all five initial conditions shown below in Table I-1. The initial conditions for the intra-Connecticut trajectory were determined by scaling down the New York Metro conditions by the ratio of the southwestern Connecticut to Hudson County, New Jersey nighttime emission rate.

TABLE I-1. OXIDANT PRECURSOR DATA FOR ELIZABETH, N.J., USED AS INPUT FOR THE NEW YORK METRO-HARTFORD TRAJECTORIES

Period of Measurement	Initial conditions	
	NMHC (ppm C)	NO_x (ppm)
Oxidant season 1974	1.51	0.20
Oxidant season 1976	2.04	0.13
Oxidant season 1977	1.49	0.12
5 Highest oxidant days 1974	1.57	0.07
Worst case combination	2.04	0.20

The atmospheric dilution rate is determined from the difference between the morning and afternoon mixing depths. The importance of mixing depth for the trajectory ozone values was assessed by using both a typical mixing depth of 1300 meters[6] and the default limited mixing depth value of 630 meters.

Daytime hourly emission factors were determined for the two trajectories based on county emission rates in New Jersey and New York and the control region emission rates in Connecticut. In determining the spatially varying emission rates along the trajectory, a temporal factor accounting for the diurnal variation in emissions due to traffic cycles was included.[7] Tables detecting the daytime emission factors for the trajectories are provided in Appendix B.

The photolytic rate constants for 10 June 1974 were used in all the simulations. Of the trajectories documented in Appendix A this was the date of the highest ozone concentrations in Connecticut.

SECTION 2

SUMMARY OF FINDINGS AND RESULTS

NEW YORK METRO-HARTFORD TRAJECTORY: BASELINE RESULTS

The trajectory originating in the New York Metro area was simulated using the five representative initial conditions presented in Table I-1. For all New York Metro simulations the maximum ozone value occurred in the early afternoon, after the parcel entered Connecticut. During the first 2 hours after the maximum was reached, the ozone concentration of the parcel decreased on the order of 10 percent and remained relatively constant for the remainder of the afternoon. Since the maximum is representative of the entire afternoon, the analysis will be restricted to the maximum ozone value and the results hold true for all Connecticut trajectory locations. For comparison, the afternoon ozone surge measured at Hartford on 10 June 1974 is illustrated in Figure II-1. The magnitude of the late afternoon ozone value is typical of the episodes documented in the 1979 Connecticut SIP.

The ozone maximum predicted by OZIPP and its percent breakdown by contributing components are shown in Table II-1 for both typical and limited afternoon mixing. The component contributions were assessed by removing the day emissions and ozone aloft from model input. The model results presented in Table II-1 indicate that:

- Assuming a typical mixing depth of 1300 meters, an ozone maximum value on the order of 0.300 ppm is predicted for the New York Metro trajectory. This is on the order of the measured late afternoon ozone values in Connecticut.

- Ozone aloft and Connecticut afternoon emissions contribute little to this late afternoon maximum.

- Seventy percent of the late afternoon maximum is due to New York Metro night emissions in combination with the background concentrations.

- Twenty-five percent of the maximum is due to New York Metro morning emissions, independent of initial conditions.

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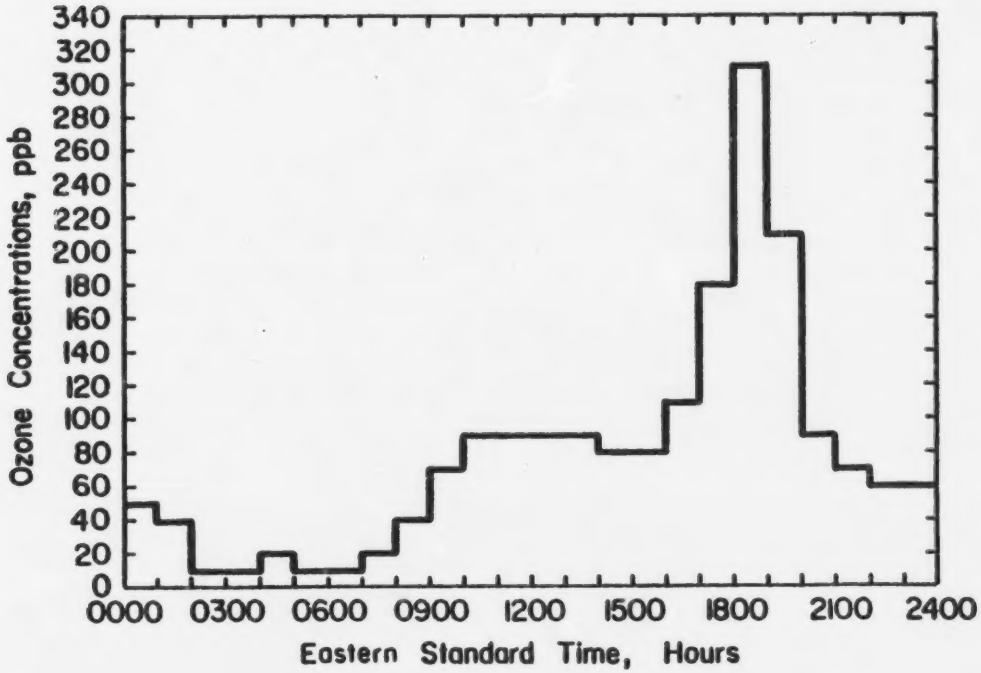

Figure II-1. Hartford measured ozone levels, ppb, 6/10/74.

TABLE II-1. THE NEW YORK METRO-HARTFORD TRAJECTORY 1-HOUR AVERAGE OZONE MAXIMUM VALUE AND THE PERCENT CONTRIBUTION OF ITS COMPONENTS

Ozone value maximum 1-hour average (ppm)	Percent incremental contribution			
	New York Metro area			
	Night emissions and background	Day emissions	Connecticut day emissions	Ozone aloft
a. Typical mixing depth of 1300 meters				
0.346	66	27	0	7
0.339	70	25	0	5
0.309	67	26	0	7
0.262	68	24	0	8
0.391	69	26	0	5
b. Limited mixing depth of 635 meters				
0.511	72	26	0	2
0.449	75	24	0	1
0.426	74	26	0	0
0.341	75	24	0	1
0.545	73	26	0	1

INTRA-CONNECTICUT TRAJECTORY: BASELINE RESULTS

The intra-Connecticut trajectory originates in southwestern Connecticut. It arrives at Connecticut locations 3 hours ahead of the New York Metro air column and is representative of conditions resulting in the early afternoon maximum. Initial conditions were determined by scaling down the three worst case New York Metro initial conditions by the ratio of baseline emissions per unit area for southwestern Connecticut to that for Hudson County, New Jersey. The resulting ozone values and percent contribution by component are presented in Table II-2. The model results indicate that:

- Ozone values in excess of the NAAQS can result from Connecticut emissions alone. The values, however, are much lower than the New York Metro trajectory values.
- Unlike the New York trajectory, morning emissions are equal in importance to nighttime emissions and background concentrations.
- The ozone aloft plays a much greater role, assuming a typical afternoon mixing depth. This is largely due to the reduction in the maximum value.

THE CONNECTICUT OZONE PROBLEM

Connecticut air quality data shows that the highest ozone values, on the order of 0.300 ppm, occur in the late afternoon or early evening. The maximum ozone value should occur near noon if local emissions were the cause. The data also reveal that the late afternoon maximum occurs at later times moving from the southwestern corner of the state toward Hartford. Based on these observations, transport of ozone and its precursors appears to play an important role on days when the highest ozone values are recorded in Connecticut.

The study assessed the probable impact of two transport scenarios that meteorological data reveal to be quite common during high ozone episodes by means of the OZIPP model. The first scenario considered long range transport of New York Metro night and morning emissions while the second was representative of the transport of intra-Connecticut night and morning emissions. The photochemical modeling results show that New York Metro emissions can indeed account for a late afternoon ozone maximum in Connecticut of the magnitude observed. The modeling exercise also shows that Connecticut emissions alone can cause exceedance of the NAAQS for ozone. Specifically, the New York Metro trajectory results in late afternoon ozone values on the order of the observed 0.300 ppm while Connecticut emissions alone produce ozone values on the order of the NAAQS of 0.120 ppm. Furthermore, since the emission rate per unit area is nearly uniform between Bridgeport and Hartford, the intra-Connecticut results apply to a number of trajectories, all of which would result in local noon maximums near the ozone NAAQS.

TABLE II-2. THE INTRA-CONNECTICUT TRAJECTORY 1-HOUR AVERAGE OZONE MAXIMUM VALUE AND THE PERCENT CONTRIBUTION OF ITS COMPONENTS

Ozone value maximum 1-hour average (ppm)	Percent incremental contribution			
	Connecticut emissions		New York area emissions	Ozone aloft
	Night	Day		
a. Typical mixing conditions; afternoon mixing depth of 1300 meters				
0.130	40	39	0	21
0.126	41	38	0	21
0.142	41	41	0	18
b. Limited mixing conditions; afternoon mixing depth of 635 meters				
0.185	44	52	0	4
0.179	44	52	0	4
0.207	44	53	0	3

The New York Metro-Hartford trajectory resulted in much higher ozone values than the intra-Connecticut trajectory largely because the New York Metro emissions are of an order of magnitude greater. The difference in the magnitude of the maximum concentrations predicted by the two scenarios will become important in the analysis of the effects of proposed SIP control strategies. As will be demonstrated in the next subsection, the violation caused by the New York Metro trajectory is much more difficult to bring below the current NAAQS.

IMPACTS OF SIP CONTROL STRATEGIES

As part of this special study of ozone transport, the reductions of the ozone maximum for both the New York Metro-Hartford and intra-Connecticut trajectories in the years 1982, 1987 and 1990 were estimated under the following control assumptions:

- Pre-1979 SIP controls only
- 1979 SIP controls on point and area HC sources
- 1979 SIP controls on point, area and mobile HC sources

The initial conditions for the baseline parcel originating in the New York metropolitan area were reduced by the ratio of projected to present emissions per unit area for Hudson County, New Jersey, with NO_x and NMHC being considered separately. Initial conditions for the parcel originating in southwestern Connecticut were determined by reducing baseline New York Metro initial conditions by the ratio of its projected emissions per unit area to those for Hudson County, New Jersey. The NO_x and NMHC emissions are not reduced uniformly across the region; therefore, besides changing the initial conditions, GCA also had to determine hourly emission factors for both NO_x and NMHC.

The maximum ozone concentrations predicted by OZIPP assuming the three control strategies listed above are shown in Table II-3. The modeling analysis shows that:

- Even assuming full implementation of the 1979 SIP revisions in the study region, the New York Metro-Hartford trajectory maximum ozone value will still exceed the NAAQS in 1990.
- Existing controls alone will have little effect on reducing the ozone maximum for either trajectory, although the values for the intra-Connecticut trajectory will be at or slightly below the NAAQS by 1987.
- With full implementation of the 1979 SIPs the predicted ozone maximums for the intra-Connecticuty trajectory fall well within the NAAQS by 1987.

TABLE II-3. IMPACT OF CONTROL STRATEGIES ON 1-HOUR AVERAGE MAXIMUM OZONE VALUE ASSUMING A TYPICAL MIXING DEPTH OF 1300 METERS

1977 Ozone value (ppm)	Control strategy								
	Existing			RACT (point & area)			RACT & RACM		
	Ozone value (ppm)			Ozone value (ppm)			Ozone value (ppm)		
	1982	1987	1990	1982	1987	1990	1982	1987	1990
a. New York Metro-Hartford trajectory									
0.346	0.308	0.293	0.284	0.254	0.202	0.188	0.252	0.193	0.183
0.339	0.296	0.282	0.269	0.268	0.226	0.211	0.267	0.219	0.209
0.391	0.345	0.326	0.316	0.291	0.239	0.227	0.289	0.232	0.222
b. Intra-Connecticut trajectory									
0.130	0.118	0.110	0.104	0.109	0.090	0.090	0.109	0.085	0.078
0.126	0.115	0.107	0.104	0.110	0.096	0.093	0.110	0.091	0.087
0.142	0.128	0.120	0.115	0.121	0.103	0.097	0.121	0.096	0.090

APPENDIX A

AIR COLUMN TRAJECTORY ANALYSIS AND COINCIDENT OZONE MEASUREMENTS

The trajectory of air parcels on days with high ozone measurement are presented in Figures A-1 through A-3.

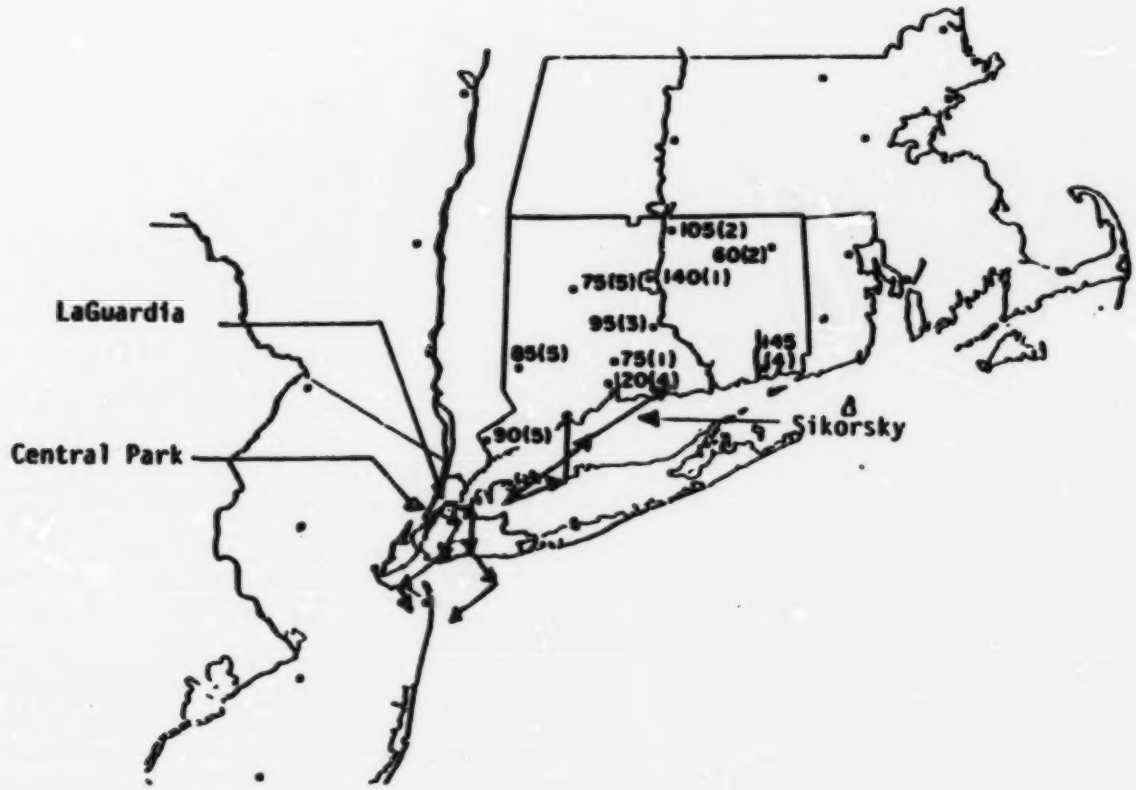

Figure A-1. Regional wind trajectories and maximum ozone concentrations (ppb) August 2, 1975 (scale 1 in. = 50 miles).

Source: Connecticut SIP (1979).

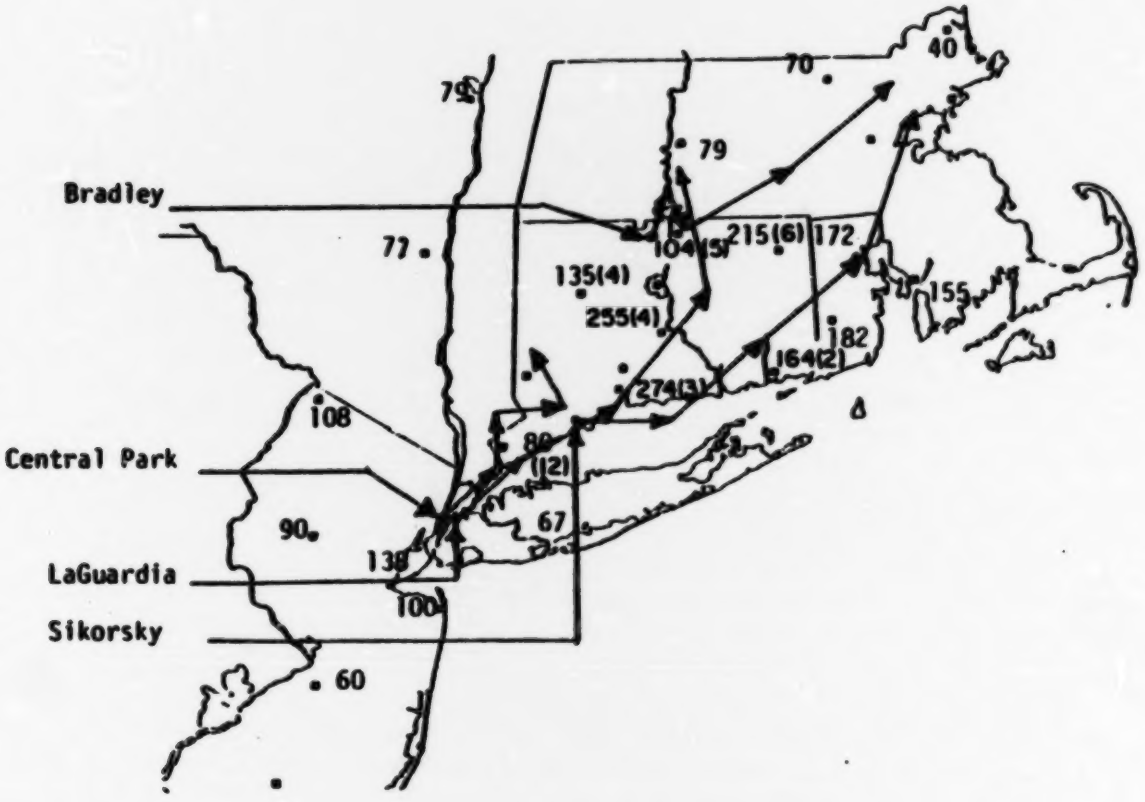

Figure A-2. Regional wind trajectories and maximum ozone concentrations (ppb) June 24, 1976 (scale 1 in. = 50 miles).

Source: Connecticut SIP (1979).

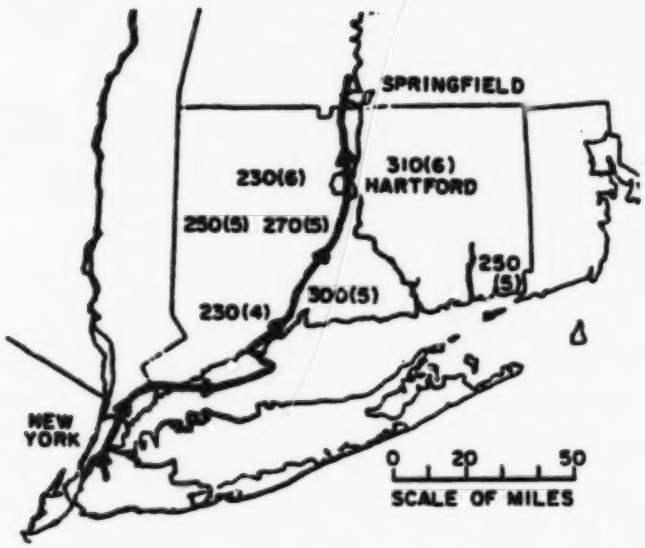

Figure A-3. Estimated hourly trajectory of air mass arriving at Hartford at 1830 hours, 6/10/74.

Source: Connecticut SIP (1979).

APPENDIX B

NORMALIZED SPATIAL EMISSION FACTOR - BASE YEAR TRAJECTORIES

Daytime hourly emissions along a trajectory are accounted for in OZIPP by the normalized emission factor which is equal to the temporal factor times the spatial factor times the percent of days emissions divided by the percent of days emissions emitted overnight at the air column's origin. The temporal factors account for diurnal variation in mobil emissions. The spatial factor accounts for the relative change in emission rate at the air column's present location with respect to the emission rate at the parcel's origin. The normalized emission factors used in the trajectory baseline year runs are presented in Tables B-1 and B-2.

TABLE B-1. DATA USED IN CALCULATION OF NORMALIZED EMISSION FACTOR FOR NEW YORK METRO-HARTFORD BASELINE YEAR TRAJECTORY

Time	Location county/control region	State	Emission rate (tons/yr^{-1}/miles^{-2}) NMHC	Emission rate (tons/yr^{-1}/miles^{-2}) NO_x	Temporal factor	Spatial factor	Percent of days emissions	Normalized emission factor
12:00-08:00	Hudson	NJ	2.00	2.1	-	-	0.169	-
08:00-09:00	Hudson	NJ	2.00	2.1	1.40	1.00	0.042	0.345
09:00-10:00	New York City	NY	2.50	3.0	1.15	1.25	0.042	0.354
10:00-11:00	Westchester	NY	0.25	0.25	1.05	0.13	0.042	0.034
11:00-12:00	Southwestern	CT	0.20	0.20	1.05	0.11	0.042	0.028
12:00-13:00	Southwestern	CT	0.20	0.20	1.05	0.11	0.042	0.028
13:00-14:00	Greater Bridgeport	CT	0.20	0.20	1.12	0.10	0.042	0.028
14:00-15:00	South Central & Valley	CT	0.40	0.40	1.3	0.20	0.042	0.049
15:00-16:00	South Central	CT	0.35	0.35	1.5	0.30	0.042	0.074
16:00-17:00	South Central	CT	0.35	0.35	1.75	0.30	0.042	0.074
17:00-18:00	Central-Midstate-Capital	CT	0.60	0.30	1.75	0.40	0.042	0.099

TABLE B-2. DATA USED IN CALCULATION OF NORMALIZED EMISSION FACTOR FOR INTRA-CONNECTICUT BASELINE YEAR TRAJECTORY

Time	Location	Temporal factor	Spatial factor	Percent of days emissions	Normalized emission factor
24:00-08:00	Southwestern Connecticut	0.51	1.0	0.169	-
08:00-09:00	Southwestern Connecticut	1.40	1.0	0.042	0.345
09:00-10:00	Southwestern Connecticut	1.15	1.0	0.042	0.284
10:00-11:00	Greater Bridgeport	1.05	1.0	0.042	0.259
11:00-12:00	South Central & Valley	1.05	2.0	0.042	0.518
12:00-13:00	South Central	1.05	1.75	0.042	0.453
13:00-14:00	South Central	1.12	1.75	0.042	0.483
14:00-15:00	Central-Midstate-Capital	1.3	2.0	0.042	0.641

APPENDIX C

INITIAL CONDITIONS AND DAYTIME EMISSION FACTORS FOR THE CONTROL STRATEGY ANALYSIS

The NO_x and VMHC emission rates per unit area are presented in Table C-1 for the control strategies assessed in this study. These projected emission rates were used to scale down the baseline initial conditions as well as to determine new spatial emission factors. The resulting model input for the New York Metro-Hartford trajectory is listed in Tables C-2 and C-3, and for the Intra-Connecticut trajectory in Tables C-4 and C-5.

TABLE C-1. NORMALIZED EMISSION FACTORS FOR NEW YORK METRO-HARTFORD CONTROL STRATEGY SIMULATIONS

County/Region	NO_x emission rates (tons yr^{-1} $miles^{-2}$)			NMHC emission rates Baseline projection (tons yr^{-1} $miles^{-2}$)			NMHC emission rates RACT (point & area) controls (tons yr^{-1} $miles^{-2}$)			NMHC emission rates RACT and RACM controls (tons yr^{-1} $miles^{-2}$)		
	1982	1987	1990	1982	1987	1990	1982	1987	1990	1982	1987	1990
Hudson, NJ	1.54	1.33	1.16	1.75	1.67	1.61	1.11	0.72	0.64	1.10	0.68	0.62
New York City, NY	2.90	2.71	2.67	1.84	1.56	1.32	1.55	1.24	1.18	1.55	1.17	1.10
Westchester, NY	0.18	0.15	0.13	0.20	0.17	0.16	0.17	0.14	0.13	0.14	0.10	0.09
Southwestern, CT	0.20	0.18	0.17	0.17	0.12	0.11	0.17	0.11	0.10	0.17	0.09	0.08
Greater Bridgeport, CT	0.17	0.16	0.15	0.16	0.13	0.11	0.15	0.10	0.09	0.15	0.09	0.08
South Central & VAlley, CT	0.40	0.36	0.26	0.31	0.23	0.19	0.25	0.16	0.15	0.25	0.14	0.12
South Central, CT	0.30	0.26	0.25	0.27	0.20	0.16	0.22	0.14	0.12	0.22	0.12	0.10
Central-Midstate-Capital, CT	0.10	0.08	0.08	0.17	0.14	0.12	0.10	0.07	0.0(	0.10	0.06	0.05

TABLE C-2. NEW YORK METRO-HARTFORD TRAJECTORY INITIAL CONDITIONS (ppm)

Year	Pollutant NMHC	Pollutant NO_x
Existing controls		
Base year	1.5	0.20
	2.0	0.13
	2.0	0.20
1982	1.29	0.14
	1.72	0.09
	1.72	0.14
1987	1.23	0.12
	1.65	0.08
	1.65	0.12
1990	1.19	0.11
	1.59	0.07
	1.59	0.11
RACT (Point and Area)		
Base year	1.5	0.2
	2.0	0.13
	2.0	0.20
1982	0.82	0.14
	1.09	0.09
	1.09	0.14
1987	0.53	0.12
	0.71	0.08
	0.71	0.12
1990	0.47	0.11
	0.63	0.07
	0.63	0.11
RACT (Point and Area) plus RACM		
Base year	1.5	0.2
	2.0	0.13
	2.0	0.20
1982	0.81	0.14
	1.08	0.09
	1.08	0.14
1987	0.50	0.12
	0.67	0.08
	0.67	0.12
1990	0.46	0.11
	0.61	0.07
	0.61	0.11

TABLE C-3. NORMALIZED EMISSION FACTORS NEW YORK METRO-HARTFORD CONTROL STRATEGY SIMULATIONS

	Existing controls						RACT (point and area)						RACT (point and area) plus RACM					
	1982		1987		1990		1982		1987		1990		1982		1987		1990	
Time	NO_x	NMHC	NO_x	NMHC	NO_x	NMHC	NO_x	NMHC	NO_x	NMHC	NO_x	NMHC	NO_x	NMHC	NO_x	NMHC	NO_x	NMHC
08:00-09:00	0.345	0.345	0.345	0.345	0.345	0.345	0.345	0.345	0.345	0.345	0.345	0.345	0.345	0.345	0.345	0.345	0.345	0.345
09:00-10:00	0.533	0.298	0.577	0.265	0.652	0.232	0.533	0.395	0.577	0.488	0.652	0.522	0.533	0.399	0.577	0.487	0.652	0.502
10:00-11:00	0.031	0.031	0.029	0.029	0.029	0.029	0.031	0.031	0.029	0.029	0.029	0.029	0.031	0.031	0.029	0.29	0.029	0.029

TABLE C-4. INTRA-CONNECTICUT TRAJECTORY INITIAL CONDITIONS (ppm)

1982		1987		1990	
NMHC	NO_x	NMHC	NO_x	NMHC	NO_x
a. Existing controls					
0.13	0.018	0.11	0.016	0.10	0.015
0.17	0.012	0.15	0.010	0.14	0.010
0.17	0.018	0.15	0.016	0.14	0.015
b. RACT (point and area)					
0.11	0.018	0.07	0.016	0.07	0.015
0.15	0.012	0.10	0.010	0.09	0.010
0.15	0.017	0.10	0.016	0.09	0.015
c. RACT (point and area) plus RACM					
0.11	0.018	0.06	0.016	0.05	0.015
0.15	0.012	0.08	0.010	0.07	0.010
0.15	0.018	0.08	0.016	0.07	0.015

TABLE C-5. NORMALIZED EMISSION FACTORS FOR INTRA-CONNECTICUT TRAJECTORY CONTROL STRATEGY SIMULATIONS

	Existing controls						RACT (point and area)						RACT (point and area) plus RACM					
	1982		1987		1990		1982		1987		1990		1982		1987		1990	
Time	NO_x	NMHC	NO_x	NMHC	NO_x	NMHC	NO_x	NMHC	NO_x	NMHC	NO_x	NMHC	NO_x	NMHC	NO_x	NMHC	NO_x	NMHC
08:00-09:00	0.345	0.345	0.345	0.345	0.345	0.345	0.345	0.345	0.345	0.345	0.345	0.345	0.345	0.345	0.345	0.345	0.345	0.345
09:00-10:00	0.284	0.284	0.284	0.284	0.284	0.284	0.284	0.284	0.284	0.284	0.284	0.284	0.284	0.284	0.284	0.284	0.284	0.284
10:00-11:00	0.305	0.275	0.291	0.239	0.294	0.259	0.305	0.294	0.291	0.285	0.294	0.288	0.305	0.294	0.291	0.259	0.294	0.259
11:00-12:00	0.518	0.472	0.518	0.496	0.396	0.447	0.518	0.381	0.518	0.377	0.396	0.389	0.518	0.381	0.519	0.403	0.396	0.389
12:00-13:00	0.388	0.437	0.374	0.431	0.381	0.377	0.388	0.335	0.374	0.329	0.381	0.311	0.388	0.335	0.374	0.345	0.381	0.324
13:00-14:00	0.414	0.466	0.399	0.460	0.406	0.402	0.414	0.357	0.399	0.351	0.406	0.332	0.414	0.357	0.399	0.368	0.402	0.345
14:00-15:00	0.160	0.272	0.285	0.374	0.366	0.350	0.160	0.189	0.285	0.204	0.366	0.192	0.160	0.189	0.285	0.214	0.366	0.200

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